TEACHER REFLECTIVE PLANNER: IMPLEMENTING PROJECT BASED LEARNING IN THE HIGH SCHOOL CLASSROOM

by

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Abstract

The intent of this research project is to inform educators about implementing Project Based Learning (PBL) at the secondary school level. The information provided in this report includes the literature and resources one can use to implement PBL and create rigorous projects for students. The Teacher Reflective Planner included in this report is based on my experience of visiting schools that are presently implementing PBL and the resources I located while embedding PBL into my grade 10 Science course. My professional and personal reflections summarize teacher challenges and suggest foundational supports that must be in place before implementing PBL under the following categories: collaborative culture, research and professional development, resource sourcing, planning and implementation, and assessment. Ultimately, teachers utilizing this resource will come to understand the necessity for shared learning, teamwork and key supports to sustain motivation and reap the benefits of PBL: students with an increased capacity for collaboration and critical thinking.

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Glossary

1st Century Learning	Skills and competencies valued by today's employer, including problem solving, critical thinking, collaboration, communication and innovation (Buck Institute for Education, 2015).
Academic Rigour	The opportunity for cognitively complex tasks to solve real problems that address essential course learning outcomes and their application (Harada, Kirio & Yamamoto, 2008).
Critical Thinking	Ability to analyze complex problems, investigate questions for which there are no clear-cut answers, evaluate different points of view or sources of information, and draw appropriate conclusions based on evidence and reasoning (Ravitz, J., Hixson, N., English, M., & Mergendoller, J., 2012, p.3).
Differentiated Instruction	An approach to teaching that advocates active planning for and attention to student differences in classrooms (Tomlinson, 2001).
Facilitation	Designing the learning experience so students work independently and collaboratively to find their own information, problem solve and develop a representative product; interventions diminish as students progressively take on more responsibility (Felder & Brent, 1996).
Formative Assessment	Assessment practices that monitor student learning to provide ongoing feedback; instructors use the feedback to inform their teaching.
Inclusive Education	All types of learners are welcomed, supported to learn and contribute in all aspects of their school (Inclusion BC, 2015).
Inquiry	Extended process or asking questions, sourcing information, using resources and developing answers.
Interdisciplinary	The inclusion of different curricular disciplines or subject areas.
Interpersonal skills	The skills used to interact and communicate with people in a productive capacity; skills required for successful teamwork.
Paradigm Shift	A change in the ways of thinking and methodology of a group.

Prescribed Learning Outcomes	The learning standards set for the provincial K to 12 education system that form the basis for curricula taught (British Columbia Ministry of Education, 2015).
Project Based Learning	A teaching method for which students gain knowledge and skills by working for an extended period of time to investigate and respond to complex problems, questions or challenges (Buck Institute of Education, 2015).
Stakeholders	The people interested or involved in a project or collaboration.
Summative Assessment	The evaluation of student learning at the end of an instructional unit or project by comparing to set standards.
Universal Design for Learning	An instructional approach that offers multiple pathways within project work to support individual learner needs, interests and skills (Brownlie & Schnellert, 2009).

Acknowledgement and Dedication

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Chapter One: Project Based Learning

The term or phrase "Project Based Learning" takes on a different meaning for different people depending on interpretation of what it means to implement PBL in the classroom. Thomas (2000) introduced a definition of PBL that supports the intended British Columbia Ministry of Education curricula as:

> Complex tasks, based on challenging questions or problems, that involve students in design, problem-solving, decision making, or investigative activities; gives students the opportunity to work relatively autonomously and collaboratively over extended periods of time; and culminate in realistic products or presentations (p.1).

Much of the PBL information presented in the literature does not provide historical pitfalls or challenges that teachers might face during the design and implementation phases. I was disappointed to discover a lack of strategies to reflect on and attempt in my own classroom setting. Designing and implementing a grade ten science collaborative, group-based learning approach made me realize the magnitude of commitment to ongoing professional development, reflection, collaboration, and finding professional mentorship. The trial and error experience was a key driver resulting in the creation of the Teacher Reflective Planner included in this project.

Project Based Learning (PBL) is an innovative education model that is part of a widespread educational reform in the United States and Canada (Alliance for Excellent Education, 2011; Mitchell, Shkolnik, Song, Uekawa, Murphy, Garet, & Means, 2005; Ravitz, Hixson, English, & Mergendoller, 2012). Currently there is a shift from the stand up and lecture style of delivery to a facilitative, skills-based approach to instruction and learning through student collaboration (Alliance for Excellent Education, 2011; British Columbia Ministry of Education, 2013). In my teacher role, I experience conversations and school initiatives that lead me to believe that our present public education model is changing and

PBL encourages more collaborative learning and student-centered teaching. From a professional standpoint, I believe it is important to encourage and foster a love for learning and attempt to build job-related skills within my students through problem solving and inquiry application.

PBL is renowned for incorporating a multi-faceted assessment as part of the learning process and often extends learning into the community and workplace, similar to that of adults in the professional world (Patton, 2012). Implementing a PBL model at any level is a step in the right direction. However, teachers must be aware of the variety of challenges as stated in the research literature and my own contributions that support this statement (Ertmer & Simons, 2005; Krajcik, Blumenfeld, Marx, & Soloway, 1994). The common challenges are themed under the following categories:

- School Structure and Culture – Class size, schedule, planning time, semester systems, management style/ support from school administration, and school culture are factors that may inhibit teacher motivation to try or continue with PBL (Cheng, Lam, & Choy, 2009).
- Paradigm Shift – For a successful PBL program, all stakeholders must commit to a fundamental shift in thinking and support. Otherwise, it will be difficult to sustain the new model when difficulties arise (Cheng, Lam, & Choy, 2009).
- Resources – The allocation of appropriate funding, equipment, personnel and time are necessary to develop a quality PBL environment.
- Collaboration - Teachers must have time to research, plan, collaborate, discuss and read/observe about the experiences of PBL teachers before implementing the program themselves (Energetic Learning Campus, personal communication, April 2-4th, 2014).

- Assessment – PBL challenges teachers to shift from traditional assessment strategies, primarily assignments and tests, to assessment focused on the learning process and student skill development within a project (Buck Institute for Education, 2014).

Despite the challenges, successful PBL implementation is not insurmountable. I strongly encourage teachers to seek professional support from colleagues and administrators before taking on the planning and design stage.

Project Rationale

The Teacher Reflective Planner serves a two-fold purpose as: 1) an opportunity to present my reflections on the trials and tribulations of implementing a PBL model in my Science classroom, and 2) a resource for fellow teachers to reflect on the development of an engaging, collaborative PBL classroom. The planner entails various sections with excerpts from my reflective journal, space for professional reflection, and tools/examples borrowed and adapted from online resources within each section as they relate to the implementation of PBL.

The notion to create the planner came from my own struggle regarding the limitation of literature on the supports that must be in place before attempting to implement PBL and how teachers fare in the process. It is my hope that the Teacher Reflective Planner eases another teacher's transition and sustains them in the learning process. The planner topics that resonated from my implementation process are: (a) an understanding and approach to collaborative group learning; (b) strategies for preparing students for inquiry research and project work; (c) professional and personal reflections on the potential challenges, solutions and strategies for improving PBL practice within the school and classroom contexts; (c) the importance of ongoing professional collaboration for a successful program; and (d) how

assessment is applied throughout the PBL process, with examples specific to my own Science 10 classroom practice.

Project Significance

Shortly before my experience of implementing Project Based Learning, I joined a professional PBL Learning Team in my school that enabled me to research various teaching and learning processes that would allow for differentiated learning in a student centered classroom environment.

Based on the information explored and shared in the school PBL team sessions, the decision was made to implement PBL as a pilot project for which I applied to be the teacher to introduce the process in my grade 10 Science class. I struggled with the quick transition of PBL as a concept discussed in our team meetings to actual program design and implementation. The transition from a concept to reality did not allow for a great deal of time for effective program planning, application and assessment design for achievement measurement and success. I felt the team rushed through the process without a lot of forethought in setting specific programming goals. I struggled with not truly understanding what PBL meant and how it would be implemented and administered in the classroom. Parental pressure and student anxiety that is manifested because of the repercussions of not meeting Ministry of Education standards for achievement was another area I really struggled with. Lastly, my uncertainty stemmed from teaching inexperience that posed as a challenge in terms of helping students meet learning outcomes and engage in deeper learning opportunities as suggested in the literature.

Summary

Research literature about Project Based Learning implementation identifies training strategies and required support when using published materials, but these findings do not fully capture the challenges of teacher-initiated PBL. The need to inform educators of the trials and tribulations of implementing PBL is the driving force leading to the creation of the Teacher Reflective Planner that will be presented in greater detail in Chapter Four of this project. My attempt to create space and opportunity for others to reflect and share their professional learning experiences as they embark on implementing Project Based Learning will hopefully benefit their work through the process.

Chapter Two: Literature Review

The purpose of this chapter is to review current literature pertaining to Project Based Learning (PBL) and the essential elements necessary to successfully plan for and implement it in the classroom. PBL is an instructional model that continues to be employed and defined by educators and researchers for several decades (Barrows, 1986; Hung, 2011; Thomas 2000). Project Based Learning is part of a large-scale shift in education towards deeper learning that is applicable inside and outside of the school environment is the underpinning of what the education system now refers to as 21st century learning. Classroom practice and student skills such as critical thinking, communication, problem solving, and collaboration in a team environment that facilitate learning are the educational foci for the 21st century (Alliance for Excellent Education, 2011; British Columbia Ministry of Education, 2013). The fore-mentioned skills are intended to address the ever-changing workplace demands for interpersonal skills such as communication and adaptability in a team setting that are transferrable in any life setting (British Columbia Ministry of Education, 2013).

The education literature presented evidence of Project Based Learning instruction as foundational for curricular planning and design, offering a broader array of learning opportunities for students. Despite evidence supporting Project Based Learning as a powerful instructional strategy, teachers are challenged by the fundamental changes to teaching methods and how they perceive their students' academic success (Ertmer & Simons, 2005). Rogers, Cross, Gresalfi, Trauth-Nare, and Buck (2010) indicated a lack of resources regarding 'teacher thoughts and perceptions on the challenges associated with implementing PBL in a statement written as "research that illustrates teachers initial experiences with implementing PBL and their thoughts on how this approach aligns with their existing

orientation to teaching is scant" (p.1).

Defining Project Based Learning

There are many proposed definitions and perspectives on how to do Project Based Learning, however the range of definitions reveals common elements that distinguish PBL from other instructional approaches. Despite the variations, the PBL model can benefit students by providing opportunities to develop and hone useful skills and content knowledge applicable to real life tasks that in turn create personalized learning (Patton, 2012). Brownlie and Schnellert (2009) reminded their readers that personalized or student-centered learning must reflect the following:

- Learning is both individual and social;
- Learning should be personally meaningful and relevant;
- Learning builds on prior experience and background knowledge;
- Students should be adaptable to different teaching styles; and,
- Students must learn curricular content and 21st century learning skills to engage with, remember, connect to, process and synthesize content (p.42).

Patton's (2012) work advocated for PBL models to have clear outcomes, excellent inquiry questions, rigorous projects with integrated themes, explicit teaching for skill development, structured timelines, built in self and peer assessment, and an interesting hook into each problem or topic for optimal student learning. Ertmer and Simons (2005) supported these features by describing PBL as student-centered learning that comprises a teaching/learning framework designed to promote deep understanding of subject matter content in conjunction with the development of higher-order thinking skills. Ritz (2012) described students as being truly engaged and in charge of learning when they extend their

thinking and application to learning through community based problems, collaborating with community experts, problem solving and integrating many subjects all at once.

Teachers as Project Based Learning Facilitators

It is essential that teachers develop a roadmap when planning for a PBL program. The roadmap or conceptual theory should include a vision statement, program goals, program outcomes and the identification of the primary stakeholders (parents, students, administrators and school staff) associated with the program. The expectation of meeting provincial Ministry of Education curricular outcomes is very much at the forefront of implementing PBL while attempting to provide an array of learner opportunities. The *teacher best practice* as described in the literature supports the notion that a Project Based Learning facilitator provides student centered instruction. Savery (2006) suggested teacher facilitators use discretion as to how much information/guidance they provide with the intent to develop learner curiosity, to ask well-developed questions, to offer a problem as a project, and to guide an investigation to a solution. Previous to Savery's work, Felder and Brent (1996) supported the notion of facilitated opportunities for students to learn in groups and to develop communication, dispute resolution and project management skills. In recent years, PBL instructors have been characterized as models of excellent problem solving and reasoning, rather than disseminators of information and knowledge (Hung, 2011). Based on professional experience and the knowledge in the literature, one might assume it would be beneficial to further PBL facilitator training in teacher education and professional development.

A facilitator designs the learning experience so students have the opportunity to work independently and collaboratively to find their own information, problem solve and develop a representative product (Felder & Brent, 1996) and as interventions diminish, students

progressively take on more responsibility in learning. Hmelo-Silver and Barrows (2006) summarize the PBL facilitator's performance goals as the following: (1) keep all students active in the learning process; (2) keep the learning process on track; (3) make the students' thoughts and their depth of understanding apparent; and (4) encourage students to become self-reliant for direction and information. The students who are used to receiving detailed information and having their questions answered immediately, may resist the new role.

Planning for Project Based Learning

My experience and knowledge indicating the level of difficulty teachers might find with implementing PBL in their classrooms is supported in a statement in the literature, "despite prevalent recommendations for the adoption of PBL approaches, the transition is not easy" (Ermter & Simons, 2005, p.1). Teachers planning to implement PBL in their classrooms must have time to properly plan and have many supports in place to successfully navigate the change in practice. Teachers who dive into project based learning without adequate planning and design often get lost in the process, thus reverting to old habits when challenges arise has been advocated in the literature (Blumenfeld, Soloway, Marx, Krajcik, Guzdial, & Palinscar, 1991; Ertmer & Simons, 2005).

Program planning at the school level. Teachers should make fundamental changes to how they facilitate student learning in PBL. Teachers with the support of an ongoing, interdisciplinary collaborative team are likely to develop a sound theoretical understanding of the approach, facilitative skills, project resources and preparation time required in the planning and implementation phases of PBL (Cheng, Lam, & Choy, 2009; Ertmer & Simons, 2005; Hung, 2011; Krajcik, Blumenfeld, Marx, & Soloway, 1994). The interdisciplinary team is composed of interested teachers, support personnel, administration and community

experts who can offer different skill and academic expertise. According to Dufour, Dufour, & Eaker (2002) professional collaborative teams must consider the following areas:

- Have a clear mission and vision;
- Hold shared values and beliefs (ex: see themselves as lifelong learners);
- Work collaboratively to determine best practices to achieve mission;
- Have a teacher leader or facilitator with experience;
- Focus on student learning; and,
- Be goal and results oriented.

The evidence in the literature reveals collaboration as a major contribution to teacher wellbeing, maintaining academic rigour and finding best assessment practices in a successful PBL program (Berger, 2003; Ertmer & Simons, 2005; Hung, 2011; Lam, Cheng & Choy, 2009). If collaboration is not a possibility at a particular school due to either a lack of funding or interest, then one should seek online mentorship (Boss & Krauss, 2010) through an organization that has had success such as the Buck Institute.

A strategic team planning process should determine how students will benefit and why it is being implemented (Centre for Disease Control and Prevention, 2008). It is important for the planning team to remember that when PBL theory is introduced to the classroom environment problems may emerge as reality and classroom dynamics present variables that could not have been foreseen (Hung, 2011). A program vision articulates what the program wishes to attain and how it will do so, but also acts as a guide to navigate potential challenges. Brownlie and Schnellert (2009) suggested that a team collaboratively develops the program's vision by developing a mental model of effective learning in line with the PBL approach.

The short and long-term program goals should focus on collaboration, communication and critical thinking to further students' educational pursuits as well as later employment (British Columbia Ministry of Education, 2013). It is important that skills are embedded in the learning process and program goals to ensure a true sense of PBL application (Harada, Kirio, & Yamamoto, 2008; Larmer and Mergendoller, 2010). Furthermore, Harada, Kirio & Yamamoto (2008) assert that PBL program goals should embody the four R(s):

- Rigour – opportunity for cognitively complex tasks to solve real problems that address essential course learning outcomes and their application;
- Relevance –personalized, meaningful learning that connects to the real world and provides multiple pathways for a diverse group of learners;
- Relationships – productive collaboration and communication among students; and,
- Reflection – culture of continuous self and peer-assessment and an increasing ownership of learning.

Finally, program stakeholders must be identified and informed about the program vision and goals. The team should consider the following concerns regarding the involvement of stakeholders: a) the interest of stakeholders affected by the program; b) potential conflicts/issues with stakeholders that could negatively impact the program; c) opportunities and relationships to be developed through implementation; and d) strategies for stakeholder engagement in the program (World Wide Fund for Nature, 2005).

Program planning with a cross-curricular network. A collaborative, cross-curricular network is composed of the participants involved in the design and delivery of projects: teachers from different subject areas, community guest experts and parents with a

skill/expertise to share. Ongoing collaboration that includes a variety of skill sets, academic backgrounds and perspectives is beneficial to PBL design and delivery of rigorous and engaging projects. Once the program vision and goals are solidified, the network can begin designing projects. Patton (2012) suggests starting with a project idea that interests the team, choosing an end product for students to work towards (a focus) and then employing a backwards design approach. Brownlie and Schnellert (2009) also advocated for backwards planning for project creation. The backwards planning involves the following steps:

- Identify the essential learning outcomes;
- Identify the thinking strategies/skills for project completion and assessment;
- Select an engaging project topic, idea or end product that align with essential learning outcomes;
- Create a task timeline;
- Align the formative and summative assessments; and,
- Explicitly teach and assess the thinking skills (Brownlie & Schnellert, 2009).

Planning for assessment. A Project Based Learning assessment plan presents new challenges from the assessment often used in regular classroom approaches. Assessment strategies must align with program goals, provide equal attention to skill development and content knowledge, and realistically measure individual student performance within collaborative work settings (Ertmer & Simons, 2005; Patton, 2012).

Formative assessment strategies should focus on developing student competency through self and peer assessment. A protocol, like the *Project Tuning Protocol* (see Appendix B), can be created to teach students formal group critique (assessment) in order to: a) share knowledge and skills; b) identify what constitutes excellent work; c) provide

constructive feedback; and d) develop common criteria for success. If used consistently, formal critique gives rise to informal peer critique (Berger, 2003). Berger explains that students must be taught specific critique guidelines and vocabulary to ensure peer feedback is kind, helpful and specific.

Summative assessment requires detailed rubrics (created with student assistance) to determine grades from archived evidence of learning and the end-of-project presentation of learning (Mergendoller & Thomas, 2005). Patton (2012) advocates for the final assessment to ask the following key questions: a) Does the product meet or exceed the criteria set at the start of the project?; b) Have students developed the skills required for the execution of this project?; and c) Has the student learned the essential learning outcomes required for this project?

Planning for a collaborative classroom community. Collaborative community is designed for every learner to feel responsible for peer support and know they can depend on others for help (Kolodner, Camp, Crismond, Fasse, Holbrook, Puntambekar & Ryan, 2003). Classroom teachers should facilitate and foster inclusivity and relationship building while maintaining high expectations for academic rigour (Brownlie & Schnellert, 2009; Patton, 2012; Berger, 2003). Brownlie and Schnellert (2009) offered several instructional strategies that support such a community:

- Universal Design for Learning – create multiple pathways within project work to support individual learner needs, interests and skills;
- Gradual Release of Responsibility – facilitate student learning through teacher modeling and coaching, student practice, and the availability of immediate, specific feedback;

- Peer Assessment – build student capacity to critique peer work according to success criteria and offer kind, specific and helpful feedback; and
- Self-Reflection – facilitate student ability to critique their own work based on success criteria.

Tomlinson (2001) also offered many approaches to differentiating learning tasks to support and engage a diverse group of learners that will work toward encouraging a positive and supportive learning community. It is important that all learners work collaboratively to meet project expectations, but also able to experience individual options on how to do so.

Lastly, teachers must carefully design the classroom environment to align with the intended work to be done (Energetic Learning Campus, 2014). The design should include rituals for student and teacher behavior, a time management framework, the use of classroom space, boundaries for online work, required resources, and the integration of technology (Ertmer & Simons, 2005; Mergendoller & Thomas, 2005). Individual teachers will approach this differently when planning for scheduling time between whole class activities, small group lessons, independent/group work and online work time. It is crucial for teachers to maintain structure and rigour in the PBL classroom, as many students are unable to manage extended inquiry activities without support (Mergendoller & Thomas, 2005).

Implementing Project Based Learning

Project Based Learning can be implemented through carefully designed projects that promote active learning experiences and student ownership of learning once initial program planning is completed (Felder & Brent, 1996). It is important to note that PBL is based on an assumption that ideal conditions such as ideal learners, ideal facilitators and ideal situational conditions are prevalent. The literature suggests that the classroom environment must have

intrinsically motivated students with a desire to solve problems through collaboration in the presence of an effective facilitator (Hung, 2011). These ideal conditions are not present in every classroom and often must be modeled and taught to students over time. Larmer and Mergendoller (2010) summarized several key elements to successfully implement PBL in the classroom as:

Group learning and collaboration. Collaborative learning is the mutual encouragement of participants in a coordinated effort to solve a problem together (Dillenbourg, Baker, Blaye, & O'Malley, 1995). Students learn "the fundamental skills of productive communication, respect for others, and teamwork while generating ideas together" (Bell, 2010, p.41). Bell stipulated that students are taught and encouraged to enter a workforce and to be evaluated on collaborative, negotiating, planning, and organizational skills in addition to final productivity.

Developing a need to know. Project Based Learning projects are central to the school curriculum which often entail many need-to-know factors that stem from a central driving question (Larmer & Mergendoller, 2010). Larmer and Mergendoller also advocated the need to develop real inquiry beginning with student questions, generating new questions and testing student ideas. Ertmer and Simons (2005) supported the process of looking at complex issues, conflicts, puzzles or controversial decisions as the basis of a need to know.

Framing a driving question for projects. According to Tomlinson (2001), the motivation to learn increases when students feel a kinship with, interest in or passion for what they are attempting to learn. A driving question for a project should initiate and focus the inquiry, capture and communicate the purpose, create challenge and interest, and guide the project work (Miller, 2011). Patton's (2012) criterion for an excellent driving question as

it relates to real world experiences are: (a) The question should be one that people might ask in the real world; (b) The question will not have an easy answer; and, (c) The question should ignite student imagination.

Designing a project. Project Based Learning requires careful and significant teacher planning before the project is introduced to students (Ertmer & Simons, 2005; Larmer & Mergendoller, 2010; Patton, 2012). In my professional opinion based on experience, a PBL unit is not as straightforward or simple as a regular classroom setting unit plan.

Providing student voice and choice. Making space for choice allows for students to increase their ownership and responsibility in the learning process. Hung (2011) cautions, while choice is important to PBL, there is a delicate balance between freedom to learn and meeting curriculum objectives. Larmer & Mergendoller (2010) advocated for teachers, as facilitators, to set the stage and parameters to guide the students through the process.

Developing 21st century skills. Project Based Learning provides students the opportunity to practice 21st century learning skills such as collaboration, communication, critical thinking, and the use of technology (Larmer & Mergendoller, 2010). The B.C. Ministry of Education Plan (2013) focus on the 21st century skills reflects educational pursuits and future employment. It is advocated that the skills be embedded in the learning process and not explored as add-on areas to fulfill curricular expectations (Harada, Kirio, & Yamamoto, 2008; Larmer and Mergendoller, 2010; Patton, 2012).

Figure 2.1. 21st Century Learning Skills in Project Based Learning

(CT) Critical Thinking Skills refer to students being able to analyze complex problems, investigate questions for which there are no clear-cut answers, evaluate different points of view or sources of information, and draw appropriate conclusions based on evidence and reasoning.

(CO) Collaboration Skills refer to students being able to work together to solve problems or answer questions, to work effectively and respectfully in teams to accomplish a common goal and to assume shared responsibility for completing a task.

(CM) Communication Skills refer to students being able to organize their thoughts, data and findings and share these effectively through a variety of media, as well as orally and in writing.

(CR) Creativity and Innovation Skills refer to students being able to generate and refine solutions to complex problems or tasks based on synthesis, analysis and then combining or presenting what they have learned in new and original ways.

(S) Self-Direction Skills refer to students being able to take responsibility for their learning by identifying topics to pursue and processes for their own learning, and being able to review their own work and respond to feedback.

(G) Global Connections refers to students being able to understand global, geo-political issues including awareness of geography, culture, language, history, and literature from other countries.

(L) Local Connections refers to students being able to apply what they have learned to local contexts and community issues.

(U) Using Technology for Learning refers to students being able to manage their learning and produce products using appropriate information and communication technologies.

Figure 2.1. Defining the 21st century learning skills addressed in project-based learning. Reprinted from "Using Project Based Learning to Teach 21st Century Skills: Findings from a Statewide Initiative," by Ravitz, J., Hixson, N., English, M., & Mergendoller, J., 2012, *Annual meeting of the American Educational Research Association*, April 16, 2012, p.3.

Critiquing and revising student work. Project Based Learning aims to develop habits of learning; work through challenges and create something of quality with relevance and meaning. Peer critiquing is embedded in daily class work from which students are taught to critique, revise, accept and respond to constructive criticism (Berger, 2003).

Presenting project learning. Project Based Learning environments encourage sharing of work with others including: classmates, teachers and public audiences consisting of parents, community guests, and other students. The act of presenting projects to an outside audience brings about a sense of investment resulting in an enhanced level of confidence and pride as stated in Berger (2003) and Larmer and Mergendoller (2010). The opportunity to exhibit learning sends a clear message to students that their hard work matters beyond an assigned grade (Berger, 2003, Patton, 2012). The celebration of learning is often more about reflecting on the learning process than the actual sharing through questions posed as: What challenged you?; What were you most proud of?; and, What will you do differently next time? (Energetic Learning Campus, 2014).

Summary

The literature presented an essential element of Project Based Learning as summarized by Berger (2003) in stating: "It is through students' ownership of their work that their self-worth will grow" (p. 65). In my professional teaching practice, I often reflect on *why I do what I do*. In the process of working through this master's project, I respond to this statement with my own reflections such as: Do I give all students the best possible chance to become citizens of value?; Do I push and challenge students to develop a sense of self-worth?; or, Do I focus on checklists of content outcomes and professional standards? After considerable reflection, I have come to realize my goal is to focus on student achievement

and success in developing strong interpersonal skills while continuing to meet obligatory content goals stipulated in the BC Education Plan (British Columbia Ministry of Education, 2013). My professional practice reinforces the idea that student positive self-image emerges when they begin to make discoveries that impress their classmates, solve problems as part of a group, put together projects that are admired by others and produce work of real value.

Despite the evidence presented in the literature that clearly supports Project Based Learning as a powerful instructional strategy, it poses numerous challenges for teachers and students. Implementing PBL requires fundamental changes to teaching methods and demands change in how teachers perceive their students and what academic success means (Ertmer & Simons, 2005). It is through my own reflective practice that I am in a position to contribute to educational literature through this Teacher Reflective Planner.

Chapter Three: Methodology and Creating a Teacher Reflective Planner

The purpose of this project was to design a Teacher Reflective Planner based on my experiences of implementing a Project Based Learning approach to teaching grade 10 Science in the BC public secondary school system. The implementation process required fundamental changes from past teaching practice. The discovery of many challenges and rewards during the process provided the foundation for which the Reflective Planner is based on. Current literature reviewed to carry out this particular research project provided excellent "how to" information from highly motivated teachers and students working in ideal, collaborative settings. However, a gap exists in the literature regarding teacher real life stories of the process and supports they need to foster and sustain PBL in the school environment. The intent of the planner is to express a perspective from my point of view to inform educators of the trials and tribulations of implementing Project Based Learning in a diverse classroom setting.

The key themes emerging from this research project were organized into sections as: Collaborative Culture; Research and Professional Development; Resource Sourcing; Planning and Implementation; Assessment and Evaluation; and, an Introductory Science 10 Biomes Unit which are presented in greater detail in Chapter Four.

Project Methodology

Evidence based research and online information pertaining to Project Based Learning theory was valuable and abundant, but the teacher voice and perspective on implementing PBL was missing in the literature. Rogers, Cross, Gresalfi, Trauth-Nare and Buck (2010) supported this thought in stating, "Research that illustrates teachers initial experiences with implementing PBL and their thoughts on how this approach aligns with their existing

orientation to teaching is scant" (p.1). The information and resources presented in the project omitted data sources such as student reflection, student work, interviews from colleagues, or input from consultants because I felt this project did not need to involve other people to provide a snapshot of what I had experienced in the planning and implementation process.

Reflective Planner Overview

The purpose of this project was to offer support and reflective thoughts in the following areas of implementing PBL: (a) to assist teachers in working through the challenges of implementing PBL; (b) to offer easy to use, practical suggestions for teachers and support personnel; (c) to offer space in each section for teachers to record their own reflections; (d) to offer resources for the transition from traditional practice to PBL; (e) to introduce strategies for preparing students for PBL and create a culturally-responsive approach to group learning; and, (f) to personally reflect on my own PBL practice.

Collaborative culture. The school community includes many potential stakeholders in the PBL process such as the whole student population, parents, teachers, librarians, support staff (especially those who work in the PBL classroom), administration, district staff, invited community guests/experts, and school counselors. The collaborative culture planner section discusses the creation and necessity of an interdisciplinary collaborative team to plan for and sustain a PBL program: to develop a clear vision and program framework before implementing in the classroom. The section introduces strategies for building a foundation of relationship and collaboration in efforts to prepare students for group-based project work, pre-teaching necessary skills before project work, and developing a responsive community in the classroom that is inclusive of all learning styles and levels.

Research and professional development. The interdisciplinary team conducts research and professional development to foster a deep understanding of the PBL approach and effectively engage in program planning, project design, project implementation and the assessment of student success. The section explains the necessity of ongoing professional development with colleagues through the planning and implementation phases of a successful PBL program. The research process occurs before implementation and involves the following observations of PBL programs, the collection and analysis of appropriate resources, mentorship by experienced PBL facilitators and shared learning between colleagues.

Resource sourcing. Personnel and material resources are important considerations during the planning phase of a PBL program. The section discusses selecting and sourcing essential material resources such as: space, increased class time, budget, technological tools and a resource bank.

Planning and implementation. The section discusses the creation of program skill and essential curricular goals as mandated by the British Columbia Ministry of Education. Equally important to setting program goals is the development of a means with which to evaluate the program's success before implementing. A solid evaluation will inform the program stakeholders what is working and what next steps to take to improve both the instruction and learning of students.

Assessment and evaluation. Developing a plan for PBL assessment includes the use of formative assessment strategies such as self-reflection, peer assessment and work portfolios that may differ from those in a more stand and lecture style classroom. The section provides formative and summative assessment suggestions for the interdisciplinary team to

consider in terms of project planning. The suggestions provided were based on a project design approach adapted from Patton's (2012) *Work that Matters*.

An introductory unit: world biomes. The introductory unit provides a sample of PBL planning and delivery in my Science 10 classroom. The unit's inclusion demonstrates initial efforts I took to change my instructional practice and assessment methods towards a more relevant, student-centered style of learning.

Conclusion. The concluding statements of the planner provide an account of my personal and professional reflective thoughts regarding teaching practice and approaches to encourage teachers to implement PBL in their classrooms.

Summary

Chapter three provided the readers with a description of the research methodology and an introduction to the Reflective Planner sections that are presented in greater detail in the upcoming chapter four of this research report. At this point in the report I would like to remind the readers that the reflective planner does not explain every facet of Project Based Learning in detail, but offers practical steps and professional insight to PBL implementation.

Chapter Four: Teacher Reflective Planner

The teacher reflective planner is based on my professional experience of implementing Project Based Learning (PBL) in a Grade 10 Science course. The planner provides suggestions regarding the complexities and challenges associated with implementing PBL. The planner idea formulated out of the discovery that there are limited discussions about the supports that must be in place for project implementation and how teachers fare in the process.

The following sections introduce the reflective planner, a snapshot of implementation challenges, author comments and reflective space organized for planner users in tables at the end of Chapter Four as: Collaborative Culture; Research and Professional Development; Resource Sourcing; Planning and Implementation; and Assessment and Evaluation. The planner concludes with a sample introductory unit from my Science 10 classroom.

Collaborative Culture (Table 4.1)

A school culture that supports and embraces PBL through collaboration toward a common goal provides learning opportunities as projects unfold and more coworkers become interested in PBL. The school culture as I saw it in action involved the school community as a whole and the approach used in the classroom environment.

School community. The whole school community is comprised of cross-curricular teaching staff, school administrators, guidance counselors, librarians and information technology (IT) teachers, parents, and community guest experts. Guest experts are adults working in the greater community who may lend specific skills and knowledge to a project. The whole school community impacts the success of PBL implementation by providing essential supports for teachers. During the PBL planning stage, one should advocate for the

development of a sustained collaborative process to support teacher practice change needed for effective program development. Prior to implementation, I recommend utilizing one school year to collaborate with an interdisciplinary team of stakeholders in the school community (teachers, administration, library, counsellors and IT staff) to develop the program vision statement and framework in which the school culture must be considered (beliefs, values, cultural diversity, teaching practices and vision).

Counsellors and administrators may be looked upon as gatekeepers to the PBL program because of their role to advertise and promote PBL and assign students to the program. It is important for the success of the program that school counsellors and administration have a clear understanding of the program's vision and goals in order to effectively support student scheduling and positive classroom dynamics. Achieving buy-in from all levels in a school environment will assist with generating overall program support, attracting new resources and expertise, providing collaborative opportunities, generating project ideas and achieving consistency in instruction and assessment across departments.

Classroom approach. The interdisciplinary team should advocate for and develop a classroom community to support and reflect the four R(s) of PBL representing collaborative relationships, rigorous learning, relevant learning and reflective thinking. The implementation of PBL must consider building a classroom community through the following:

- Development of teacher facilitative skills
- Facilitation of collaborative relationships

- The adoption of inclusive teaching strategies to: a) understand and support all learners; b) pre-teach important collaborative, assessment and academic skills for project work; and, c) build student confidence prior to beginning group project work.

Early instruction and classroom work fosters a supportive learning environment that encourages student collaborative relationships. Collaboration that extends into both the school community and greater community is powerful in providing real life context and meaning for student project work. Students require instruction in formative peer-assessment and self-assessment skills to support each project. Before introducing project work, students must be taught to express oral and written ideas in a respectful and creative manner. Interpersonal communication requires students to communicate respectfully on differing perspectives and controversial topics: ask appropriate questions and gather information before asserting ideas on peers (ex: "How do you plan to present the…"). Academic communication requires the following skills to be honed: ask valid questions prior to research; select and organize the most pertinent information; brainstorm and organize ideas to develop original content; and, present information to an audience in an engaging, thought-provoking, clear manner. Scheduling class time for students to practice and receive feedback on communication skills essential to group project work is imperative.

I did not have the good fortune to work with a school based interdisciplinary collaborative team for PBL planning. I organized short-term collaborations with several university professors and greenhouse curators for an introductory Science 10 World Biomes Unit. The overarching goals at this level were to facilitate student collaborative and communication skills and provide real world connections during project work. I was also able to invite a local journalist to work with my students to develop interview skills that can

be applicable to all project work. The students' reflections revealed they really liked working with the community experts. I reflected that earlier professional collaboration would have improved the quality of the World Biomes Unit in both content and facilitation.

Facilitating collaborative learning requires skills that are vastly different from those presented in the more traditional teacher-directed, lecture-based learning environment. I found the adoption of a facilitative model somewhat challenging after the more traditional approach of requiring all students to depend on me for information and to complete the same tasks to learn curricular content. I suggest having a PBL mentor in place to help guide the development of facilitative language and instructional strategies to increase student ownership of learning.

A culture of long-term interdisciplinary collaboration was reinforced as being essential for PBL while observing the Energetic Learning Campus in Fort St. John, British Columbia. I witnessed a Science 10 teacher pitch a Myth Busters Project that included an entry event to hook students, possible driving question(s), curricular learning outcomes and skills, a timeline and an assessment rubric to create an end product (iMovie). The project facilitator posed several questions for interdisciplinary team discussion to formalize the project details as required for project tuning (see Appendix B). The facilitator's colleagues planned to support the project by pre-teaching the requisite 21st century skills essential for student success on the project. For example, the humanities teacher planned to craft deeper questions to conduct evidence-based research while the digital media teacher taught producing and editing movies using iMovie.

In summary, interdisciplinary collaboration benefits program and project design, assisting students to make connections across subjects, acquire essential communication

skills and think critically in different contexts. Ongoing collaboration transforms an enormous volume of independent teacher work to a shared and manageable process resulting in quality student projects and learning. The following questions may be considered as a starting point for the planning stage: What supports need to be put in place before implementing PBL?; and, Are staff prepared to collaborate on and facilitate a PBL process?

Please note table 4.1 reveals the standard format used throughout the planner to present key challenges I experienced and my reflections regarding those particular challenges I faced.

Research and Professional Development (Table 4.2)

Teachers new to PBL should take time for the research and planning process; otherwise, they may find themselves reverting to old habits when challenges arise. Our PBL professional learning team conducted light research and two observations of new PBL programs in our community prior to initiating our PBL program. The result was an integrated Science 10, English 10 and Socials 10 curriculum taught through projects. I feel our PBL team had a basic understanding of the approach we wanted, but the planning process was rushed; we therefore lacked a clear vision, supporting goals and an assessment plan. In addition we should have recruited an experienced PBL facilitator for the team. The process unfolded on the job from day to day as trial and error and would change some things for future implementation. In hindsight, the application of follow-up observations, improved planning, collaborative reflection and ongoing discussions, on my part, would have enhanced my early understanding of PBL.

My PBL professional development (PD) focused primarily on project design consisting of independent research and an observation of the Energetic Learning Campus

program. The observation offered useful discussion points, for example, how to plan for longer project timelines in a semester program, and highlighted potential challenges with amplified use of technology in the classroom, such as navigating the Freedom of Information and Protection of Privacy Act regulations. At a professional development session post-implementation, I was advised by a PBL facilitator to revise my approach to project design:

- Find a controversial issue (hot topic), question or problem in the curriculum or a community-based problem of interest from which to design projects.
- Select an appropriate end product/goal for the project and designing backwards, scaffold tasks to reach the end product.
- Condense prescribed learning outcomes into essential outcomes (big ideas) and pull in the outcomes and 21st century skills that fit the project.
- Avoid broad coverage of prescribed curriculum because the development of 21st century skills and inquiry are far more important and require extensive class time.
- Do the project and tune it before introducing it to students.

Establishing a collaborative Project Based Learning classroom requires a shift in teaching approaches and strategies used. A project design should create space for deeper, inquiry-based learning on essential outcomes and skill development in students that encourage critical thinking and questioning. In summary, a period of research and professional development is essential for teachers to truly understand the PBL project design and delivery process.

Resource Sourcing (Table 4.3)

School resources including personnel and material assets should be carefully considered and sourced prior to executing any program. Unfortunately, with little time or help from colleagues, our PBL program was implemented without gathering resources in advance, dedicating time instead to designing projects to meet curricular obligations. Ultimately, the most important school resource missing was an interdisciplinary collaborative body to create the vision and program goals, to communicate with stakeholders and to structure the program budget, supplies, schedule and resources before project design began.

Essential material resources include the type and availability of assistive technology, availability of funding, collaboration time and a PBL information bank. Once space is available, plan the layout to facilitate PBL work and gather classroom materials; make early requests for budget and determine fund allocation; provide a detailed, informed consent letter to parents regarding technology use and personal electronic devices; and gather required technology such as computers.

Planning and Implementation (Table 4.4)

The planning phase for a PBL program is to build a framework with key elements: an interdisciplinary collaborative team; a vision statement for the program; program goals and strategies for program evaluation; the allocation of resources; structured class time; and, educating or training of all program stakeholders.

While planning for PBL I utilized the essential elements from Larmer and Mergendoller's (2010) *7 Essentials for Project Based Learning* to guide my instruction and structure project outlines. I was aware that a PBL approach envisions developing teachers

and students as flexible thinkers and effective problem solvers. However, I did not set specific short and long-term program goals or develop criteria for evaluating the program's success. I was clearly focused on curriculum delivery, but due to my lack of recorded reflective thoughts and evaluative processes, I did not have viable data to discuss the program success with school administrators.

Utilize planning time to develop program goals and means for their evaluation with the interdisciplinary team. The goals should be specific, measurable, attainable within set timelines and realistic to your particular learning environment. Consider the type of students in the environment, their previous learning experiences, life situations, comfort with technology and academic starting points. Program goals are different than prescribed learning outcomes; they provide a big picture, such as the development and application of students' 21st century skills, whereas prescribed outcomes describe what concepts and subject-specific skills will be taught and assessed through project work. Design projects that reflect the chosen program goals and vision and include a clear means for evaluating goal attainment. For example, the Energetic Learning Campus Staff described their first three years of program goal setting: Year one was deemed "chaotic" as they were setting up a new school and jumped in head first. In year two they set program goals based on what did not work in year one. By year three, the team had clear vision, goals and evaluated their progress based on feedback from students, parents, community members and the teachers themselves. The team also spent time reviewing the year's work through video and archives.

The interdisciplinary team determines the development of expectations for classroom behaviour and alignment with program goals, as this precedes successful project work. Teachers need to establish class routines with flexibility to adjust routines to meet student

needs while supporting PBL work. PBL teachers facilitate rather than direct the pacing of class time, requiring clear structure and guidelines to maintain the rigour of student work. Defined expectations, routines and learning spaces are essential for:

- Comfort in an environment different from the traditional classroom
- Time management balancing independent, group and computer-based work
- The management and integration of technology

Assessment and Evaluation (Table 4.5)

Project assessment and evaluation is crucial to PBL project design. Assessment is a substantial topic unto itself. The planner provides formative and summative assessment suggestions for the interdisciplinary team to consider in terms of project planning. The suggestions are based on the project design approach used in my grade 10 Science projects adapted from Patton's (2012) *Work that Matters*.

PBL assessment is a continuous activity with many criterion and checkpoints. Criteria are the standards on which student work is assessed or how students know they have learned what they are supposed to learn. Formative assessment strategies may include student-teacher conferences (structured conversations), peer assessments, self-assessments, and informal and formal teacher observations of student work, quizzes and reflective journal entries. These formative assessment strategies promote student independence while determining what modifications need to be made to facilitate further progress. For example, using project checklists with clear criteria allow students to track their own progress. Summative assessment strategies ascertain if students have applied learned content and skills to achieve essential outcomes, while reflecting on the learning process (personal challenges, moments of triumph, etc.). Most commonly, a grade or

percentage is assigned following the presentation of learning event concluding a project. It is important to note that the grade should include archived evidence of student learning from all stages of the project. PBL assessment generally focuses on the following points:

- Connection is created between the development of 21st century skills and the application of content knowledge. The weighting of skill attainment and the application of content are equal on an assessment rubric.
- Assessment rubrics include the same information as formative check-ins used during the project. For example, presentation skills to be assessed must be formatively assessed with feedback and practice during the project.
- Students develop ownership of the learning process.
- Peer and self-assessments include reflective thinking, critiquing work and providing feedback based on clear project criteria.
- Archival of evidence of learning includes saving drafts, photos, video and the creation and management of a portfolio system collected throughout a project – it often focuses on one aspect the student(s) chose to represent.
- Project presentations of learning include reflection on the whole learning process versus the stand-alone end product.

It is extremely important to celebrate throughout the learning journey. An example of celebrating student progress and project development carried out by the Energetic Learning Campus is the frequent presentations of learning culminating in celebrations of learning with invited guests at the midpoint and end of year. Celebrating allows students to demonstrate their learning to others.

Conclusion

The aim of the Teacher Reflective Planner is to share my understanding of the challenges that arise while implementing Project Based Learning in a Science 10 classroom. Teachers will be the first to acknowledge how difficult the change to PBL is, especially the first year. There is an abundance of information online and in research literature; yet there is little still on the practical first steps from the teacher perspective. In my opinion, shared learning and essential supports discussed in the planner must be in place before implementing PBL. I hope teachers will use the reflective space in the following tables to record their thoughts, ideas and questions. The sample unit is included at the end of Chapter Four to provide an example to introducing PBL in the Science 10 classroom, highlighting what worked well and ideas for future improvement.

Teacher Reflective Planner Tables

Table 4.1. Collaborative Culture is Critical		
Goal 1: Identify the primary internal and external stakeholders in your community **Goal 2:** Create an interdisciplinary collaborative team		
Challenge	**Author's Comments**	**Reflective Notes**
Administrative commitment to collaboration time and resources	• Advocate early for program support as ongoing collaborative planning time	
Involvement of interdisciplinary stakeholders	• Enlist librarian, IT staff, parent and guest presenters for collaborations • Example: merge creative writing with Science 10 content and invite local journalist for interview strategies	
Implement structure to guide productive collaborative processes	• Team to determine: budget, resource sourcing, class space and scheduling, program support/design and later, project design and tuning. • See Project Tuning Protocol in Appendix B	
Counselors and parent(s) informational sessions	• Counsellors must be informed to garner student and parent support • PBL program information and updates should be accessible to students, parents and community	
Enlist PBL mentor(s)	• Experienced mentorship is invaluable • Teacher skill evaluation should happen throughout PBL process	

Table 4.2. Research and Professional Development		
Goal 1: Advocate for and participate in ongoing professional development with the team **Goal 2:** Understand theory and methods for the PBL program		
Challenge	**Author's Comments**	**Reflective Notes**
Level of professional development	• Recruit/join a team of teachers from different schools and grade levels for ongoing discussions, problem solving and project design (provides different views and ideas on the PBL approach)	
Visit and observe established PBL programs	• The Energetic Learning Campus models the importance of a collaborative process for project design and teacher satisfaction	
Professional development to research and share PBL learning	• Co-present PD sessions for colleagues that share the beginner and expert perspective on PBL implementation	
Utilize online projects, collaborations, and resources	• Utilize *Reinventing Project Based Learning* (Boss & Krauss, 2010), the Buck Institute of Education (www.bie.org) and High Tech High resources (www.hightechhigh.org)	
Use a trial run to experience potential problems with PBL work	• Perform trial runs of all projects to address potential issues with overall project design, student motivation and challenge, timelines and technology usage	

Table 4.3. Resource Sourcing		
Goal 1: Decide what material resources are needed for the program **Goal 2:** Gather essential resources during the planning phase		
Challenge	**Author's Comments**	**Reflective Notes**
Determine start-up funding and budget parameters.	• Research existing PBL programs' start up funding and budgets • Prioritize funds for class computers and field trips	
Advocate for linear (year-long) programming	• Include overrun time into every project • Even with 80-minute linear classes, many projects were extended • Extending or reducing project expectations once started is challenging	
Find the physical space to support learning activities.	• PBL spaces are characterized by a flexible, open concept with: an abundance of natural sunlight, movable walls, mobile desks and chairs, a variety of workspaces for independent/group work, and ample storage space	
Ensure the technological tools are available with a lesson on the *Freedom of Information and Protection of Privacy Act* (FOIPPA)	• Students must be taught to act responsibly when working online • Protect identities by omitting personal and school identifiers • Provide parents with detailed letters about technology usage guidelines	
Create a bank of PBL resources	• Access to quality online materials and project samples saves time • A database may encourage staff to engage in PBL	

Table 4.4. Planning and Implementation		
Goal 1: Share program vision with the collaborative team **Goal 2:** Set program goals and evaluative processes before implementing **Goal 3:** Establish clear expectations and routines for classroom management		
Challenge	**Author's Comments**	**Reflective notes**
Develop a program vision with short and long-term goals	• Program goals focus on the development of 21st century skills • Short Term Goal: Utilize facilitative language to enhance problem solving • Long Term Goal: Students developing projects	
Create a means and timeline for program evaluation	• Regular program evaluation is necessary for sustaining PBL • Evaluation is based on student work portfolios, student presentations, peer-assessments and teacher and student self-reflections	
Determine essential curricular outcomes for project design	• Condense course prescribed outcomes into essential outcomes and key skills • Resist covering every prescribed outcome in a checklist fashion	
Organize instructional time and develop class routines	• Carefully balance class time between lessons, independent, group and online work • Too much time online reduces student focus and motivation • Structure time online with clear targets and accountability	
Student involvement with project design and management of classroom environment	• Students have voice and choice throughout the learning process within a planned project framework; for example, personalized approaches to learning tasks	

Table 4.5. Assessment and Evaluation		
Goal 1: Plan formative assessment to inform instruction and maintain student progress **Goal 2:** Design rubrics that provide clear targets for skill and content outcomes **Goal 3:** Teach students to self and peer-assess based on specific task criteria **Goal 4:** Ensure summative assessment reflects the whole learning process		
Challenges	**Author's Comments**	**Reflective Notes**
Plan formative assessment to keep students on track and inform lessons	• Students maintain portfolios with progress checklists • A weekly portfolio meeting maintains project pacing	
Build peer and self-assessment into each class	• Students self and peer assess using clear task criteria from exemplars • Berger (2003) offers useful guidelines in *An Ethic of Excellence*	
Project rubrics must clearly indicate levels of success	• The Buck Institute's PBL project rubrics can be modified for specific student needs or projects • Ensure students understand rubric criteria at the start of a project	
Utilize exemplars to build project rubric criteria	• An example from my class: students analyzed different arguments in the news on the Enbridge Pipeline project, created a rubric with criteria for developing sound arguments, and then assessed their own arguments using the criteria	
Decide what evidence of learning will be archived and how it is applied to summative assessment	• Set aside time each class for student archiving reflections on learning • Remind students: scattered evidence of learning makes it hard to truly discern a student's level of learning	

An Introductory Unit: World Biomes (Table 4.6, Table 4.7, Table 4.8)

Many of the challenges discussed in the planner stem from my reflections while facilitating PBL Science 10 work, particularly the World Biomes Unit. My personal goals for the unit were to:

- Introduce and facilitate the development of skills that precede project work
- Develop teacher facilitative language to guide (rather than direct) students
- Pre-teach important communication skills
- Foster relationships in the classroom community
- Introduce students to self and peer-assessment
- Understand my students' academic and personal starting points.
- Cover Science 10 essential outcomes as prescribed by the British Columbia Ministry of Education

The following subsections provide a brief look at the three-week introductory biome unit. Short projects, often called posthole units, over the course of a few weeks are ideal for introducing important skills essential to PBL project work (Holbrook, Fasse, Gray, & Kolodner, 2001). During the planning and delivery of this unit I was in the midst of a steep PBL learning curve, recognizing and negotiating the many aforementioned challenges. I hope teachers new to PBL may gain insight or ideas from the steps I took towards a more relevant, student-centered style of learning. Please note that there are many aspects of the unit I will change in the future.

Collaborative culture. The first two weeks of the semester focused on developing communication skills to support collaborative learning in the classroom. My intent was to teach students how to communicate and generate discussions as transferrable skills outside of the classroom environment. I collaborated with the school librarian to focus on teaching students how to generate solid questions to further discussion and research. In order to assess student skill development, we co-developed communication criteria for reference. Due to the limited range of collaborative opportunities within the school, I sought community experts for their areas of scientific and academic expertise. I met with several university professors to organize round table discussion sessions where students would receive brief talks on climate change effects on biomes. Three learning sessions occurred over a two week period, where professors gave students short introductions on effects of climate change in biomes (example: changes to the nitrogen cycle) followed by structured group discussion time. The student groups were asked to develop scientific questions related to possible changes in their chosen biome with assistance from the experts. Before each university session, I taught and provided feedback on group discussion skills and required curricular concepts.

Research and professional development. I was impressed by the professors' skill in answering student questions with new questions, giving rise to new ideas and forcing students to think for themselves. Upon return to our classroom, I practiced facilitating student learning in a similar manner to the professors. The round table sessions were successful for both student engagement and my personal learning.

Planning and implementation. I planned a PBL unit to broadly include 21st century skill goals mandated by the British Columbia Ministry of Education. However, I realized at a later date that each unit or project should focus on the development of only two

or three essential skills to ensure effective instruction, practice and assessment. My education experience prepared me to focus primarily on curriculum coverage in academic settings; I was therefore unsure how to effectively integrate skill development with curriculum coverage. In my opinion, the PBL approach requires the facilitation of skills like critical thinking, but many resources lack practical steps or examples on how to do so. I recommend *All About Thinking* by Brownlie and Schnellert (2009) as one resource that provides steps and examples to develop critical thinking within a unit of study.

Assessment and evaluation. Students were challenged to complete either a self-reflection or peer-assessment each day. Assessment criteria were developed with the class and we conducted practice reflections using the criteria and work exemplars. A large part of PBL is self-reflection and owning the process; I wanted my students to become proficient at reflecting on their own work and deciding what steps to take to improve. Teaching self-reflection and peer-assessment was challenging, as I had not researched strategies in advance. Rob Berger's (2003) book *An Ethic of Excellence* was recommended to me as an excellent starting point for peer assessment (critique).

Unit sample. The following includes a unit outline (Table 4.6) with essential learning and skill outcomes, a timeline (Table 4.7) and end product choices (Table 4.8). Table 4.6 provides only a partial unit outline as many unrecorded changes were made as the class progressed. The outline shows essential elements required in a PBL project, such as the Driving Question. Since this was a first attempt, there are many elements retaining a traditional style of teaching and learning. Table 4.7 presents a tentative timeline for the World Biomes Unit. The specific tasks and assessments changed daily with student progress. The students were given many choices for their unit end products to present learning; some

chose original ideas not included in Table 4.8. In the future, I will endeavor to record teacher and student reflections on the unit, as well as any changes made to the timeline or end products. The unit rubric included in Appendix C was adapted from online PBL rubrics.

Table 4.6. World Biomes Unit: Outline

Course: Science 10
Duration: 3 weeks

Introduction: The natural world can be divided into biomes based on living and non-living characteristics. Biomes change gradually over time due to changing climate and other human and natural events. Predicting an alteration resulting from climate change is extremely complex, however well developed questions about future changes can be asked.

Driving Question: What changes might we see in world biomes with a 2 degree Celsius increase in temperature over the next 40 years?

Essential Outcomes: Students will ask scientific questions and demonstrate an understanding about:

- Biomes are characterized by the interactions of its living (biotic) and non-living (abiotic) components
- Ecosystems are subdivisions of biomes and are dependent on the cycling of nutrients between abiotic and biotic components
- Biomes and their ecosystems change gradually over time due to both natural and human disturbances (British Columbia Ministry of Education, 2013).

Skill Outcomes: Students will:

- Craft meaningful, scientific questions based on content knowledge and research
- Apply content knowledge to a representation
- Practice communication skills (interpersonal and academic)
- Begin to develop peer-assessment and self-reflective skills
- Present learning in an engaging, thought provoking manner

Table 4.7. World Biomes Unit: Timeline		
Timeline for Unit	**Tasks/Lessons**	**Assessment**
Week One	• Watch video clips to learn characteristics of each world biomes • Groups research chosen biome • Co-develop a group communication rubric (whole class) • Guided practice writing reflectively • Complete small group lessons about unit concepts • Co-develop criteria for final product and presentation rubric	• Student-teacher conference (rubric used) • Self-reflection write • Group check in (checklist)
Week Two	• Attend two discussion sessions at university • Practice self/peer-assessment • Craft scientific questions lesson • Small group concept lessons • Research (ongoing) chosen biome • Select most important research information and organize (practice with template) • Complete self-reflection on communication skills	• Student-teacher conference • Peer assessment • Self-reflection write • Group check in (checklist used) • Content knowledge quiz
Week Three	• Attend final discussion session at university • Complete small group concept lesson • Complete peer assessment on group communication • Finish research • Begin creating final representation of learning • Practice presentation	• Peer assessment • Self-reflection write • Group check in (checklist) • Presentation of learning (rubric) • Content knowledge quiz
Week Four	• Present learning to class • Write the content knowledge test	• Presentation of learning (rubric) • Test

Table 4.8. World Biomes Unit: Final Presentation Choices		
Poster	A mind map	ABC Book
Powerpoint Presentation	Photo gallery	Story board/Comic
Prezie/Glogster presentation	A physical model (ex: a shoe box biome – then and now)	Story/narrative/poem/ dramatization
Blog	Change.org action plan	Other ideas: Field Trip Animation Video Tour of Biome

Summary. The introductory unit was a first attempt to change my approach to teaching Science 10, to develop my skills as a facilitator rather than director of student learning. I hope the reflective planner and sample unit generate ideas and useful reflection for readers. Chapter Five offers the project's key findings, recommendations and final thoughts on implementing PBL in the classroom.

Chapter 5: Key Findings, Recommendations and Conclusions

Working through this research project has afforded me the opportunity to step back and consider the challenges and rewards I faced as a young teacher in my first attempt at implementing a concentrated Project Based Learning approach. While PBL is not a new concept, it is evolving from a lecture-based, one-size-fits-all style to a student-centered and teamwork learning model. The Chapter 4 Teacher Reflective Planner is the culmination of my experience adopting the PBL model, reflecting on what worked and what did not and reviewing current PBL literature. Chapter 5 has been designed to highlight the research project key findings, recommendations, researcher reflections, and overall conclusions.

Key Findings and Recommendations

Project Based Learning requires shared learning and supportive teamwork from all levels within the education system often demanding the reshaping of teaching philosophies and approaches. The PBL literature supports the approach as an effective delivery model of integrated curriculum based heavily on collaboration and critical thinking. The model delivers benefits for students, teachers, administrators and others associated with the learning environment if and only if the approach is implemented properly while sustaining interest, motivation, and overall student achievement.

Administrative and collegial support must extend beyond the initial program creation and set up. Administrative and collegial support must provide guidance and mentorship at all stages of the program planning, implementation, assessment and evaluation. The early identification and connection with key supporters provides a network from which to draw resources, a variety of expertise for project development and further parent and student interest in the program. I observed an attitude or understanding that many of my teacher

colleagues and parents believed PBL to be a catchall for students struggling in the mainstream academic setting rather than a rigorous model that would benefit all learners.

In addition to a solid foundation, program continuity requires short and long-term goal setting with plans for evaluation and growth. It is imperative to integrate a community connection that will utilize community experts as guest presenters or lecturers based on interesting and relevant project work. The planning process to bring guest presenters into the school environment or the students to the community takes time and resources; my recommendation is to start that process early and seek administrative support early on in the planning stages.

Lastly, program evaluation is imperative for improved quality and sustainability of Project Based Learning in the school environment and the greater community. By looking at what does and does not work, evaluation can be used to improve service for students, parents and other stakeholders. A comprehensive evaluation will assist in securing school resources and overall support with the program for future application.

Researcher Reflections

The journey of researching and writing about my professional experiences implementing Project Based Learning in a Grade 10 Science class has made me realize the central importance of self-reflective practice in terms of my professional and personal growth. I enjoyed the opportunity to reflect on and evaluate my experience of navigating a variety of challenges, leading me to understand how little I initially knew about Project Based Learning let alone how to serve a diverse range of learner needs. Upon reflection, I was reminded of the successes and failures I experienced with implementing PBL and will prepare in greater detail with future PBL planning and program design. If there is one

thought I would like to leave my readers it is to prepare for the vast amount of time and effort required to digest what PBL is, to establish a collaborative process and to lay the ground work for students to grow into flexible and independent learners.

In completing this master's project, I present space for others to discuss and reflect on the challenges of a new instructional approach such as PBL. One such challenge was the extreme discomfort I felt to progress my teaching style from a stand-and-lecture to facilitator approach. The change led to an enhanced level of communication with students and indeed, I learned from them as much as they learned from me (technological savvy students were able to teach me as we progressed in the class). I was delighted with the remarkable learning end-products.

Despite the absence of certain key supports for me and the program, I felt moderately successful in facilitating the development of students to a certain point. In knowing this, I am better prepared for what should be done differently in order to reduce the challenges and increase the opportunities for collaborative learning at the classroom, school and community levels to support the sustainability of Project Based Learning. My goal in moving forward is to seek a truly collaborative process to design engaging, rigorous projects for my students.

Conclusions

Can Project Based Learning work in a regular high school classroom? I believe it can. Is it viable for teachers working independently to implement PBL in one subject area at the cost of substantial personal energy and unpaid time? Yes, with support and time for planning. Knowing that every teacher's situation is unique, the suggestions in the planner are not an exhausted list; however, they are supported by my experience and will reduce stress and anxiety of people who may be experiencing PBL implementation for the first time.

The PBL approach may initially deter students (and parents) who find comfort in the highly directive, teacher-centered classroom. It may be a challenge to convey to students and parents why PBL is a positive change, as change often means a period of trial and error. In the future, I would like to explore different program approaches for bridging student and parent support from a traditional instruction style to PBL.

My greatest lessons in regards to project based learning came from doing my Master of Education degree. The challenge posed throughout my degree was to critically think and reflect on my teaching practice and write about it. I have come to realize I was not prepared to be the facilitator and would have benefitted from professional development and a more supportive and collaborative team to work with in the process. Mentorship and guidance are imperative and, if in place, could have alleviated my stress and anxiety as a young teacher charged with implementing PBL for the first time in my teaching career. Undoubtedly, the range of emotions and life altering experiences resulting from carrying out this particular research project have influenced my thinking to be more proactive regarding professional development and seeking support well in advance for future Project Based Learning educational initiatives. My final parting note speaks to the significance of the reflective planner as a pre-planning resource to inform teachers and administrators of the potential challenges, design ideas and available resources. I soundly recommend utilizing the planner in advance of the design and development of PBL in your own school.

References

Adolescent and School Health Centers for Disease Control and Prevention (2008). *Strategic planning kit for school health programs*. Retrieved from http://www.cdc.gov/healthyyouth/evaluation/strategicplan.htm

Alberta Ministry of Education (2010). Chapter 3: Developing learner profiles. *In Making a Difference: Meeting diverse learning needs with differentiated instruction* (pp. 23-24). Retrieved from http://education.alberta.ca/media/1233960/6_ch3%20learner.pdf

Alliance for Excellent Education (2011). *A time for deeper learning: Preparing students for a changing world.* Retrieved from http://all4ed.org/reports-factsheets/a-time-for-deeper-learning-preparing-students-for-a-changing-world/

Autin, F., & Croizet, J. (2012). Improving working memory efficiency by reframing metacognitive interpretation of task difficulty. *Journal of Experimental Psychology, 141*(4), 610-618.

Barrows, H. (1986). A taxonomy of problem-based learning methods. *Medical Education*, *20*(6), 481-486.

Bell, S. (2010). Project-based learning for the 21st century: Skills for the future. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, *83*(2), 39-43.

Berger, R. (2003). *An ethic of excellence: Building a culture of craftsmanship with students.* Portsmouth, NH: Heinemann.

Blumenfeld, P., Soloway, E., Marx, R., Krajcik, J., Guzdial, M., & Palincsar, A. (1991). Motivating project-based learning: Sustaining the doing, supporting the learning. *Educational Psychologist, 26*(3 & 4), 369-398.

Boss, S., (2013). *PBL for 21st century success: Teaching critical thinking, collaboration, communication and creativity*. Retrieved from http://bie.org/shop/product_detail/pbl_for_21st_century_success

Brame, C., (2013). *Flipping the classroom*. Retrieved from http://cft.vanderbilt.edu/guides-sub-pages/flipping-the-classroom/

British Columbia Ministry of Education (2013). *BC education plan.* Retrieved from http://www.bcedplan.ca/theplan.php

British Columbia Ministry of Education (2013). *Prescribed learning outcomes*. Retrieved from http://www.bced.gov.bc.ca/irp/plo.php

Brownlie, F., & Schnellert, L. (2009). *All about thinking*. Winnipeg, MB: Portage & Main Press.

Brush, T., & Saye, J. (2000). Design, implementation, and evaluation of student-centered learning: A case study. *Educational Technology Research and Development*, *48*(3), 79-100.

Buck Institute for Education, (2014). *Why project based learning (PBL)?* Retrieved from http://bie.org/

Centre for Applied Special Technology (2014). *What is universal design for learning?* Retrieved from http://www.cast.org/udl/index.html

Cheng, R., Lam, S., & Choy, H. (2009). School support and teacher motivation to implement project-based learning. *Learning and Instruction, 20*(6), 487-497.

Costello, B., Wachtel, J. & Wachtel, T. (2010). *Restorative circles in schools: Building community and enhancing learning*. Bethlehem, PA: International Institute for Restorative Practices.

Dillenbourg, P., Baker, M., Blaye, A., & O'Malley, C. (1995). The evolution of research on collaborative learning. In P. Reimann & H. Spada (Eds.), *Learning in humans and machines: Towards an interdisciplinary learning science* (pp. 189-211). London: Pergamon.

Dufour, R., Dufour, R., & Eaker, R. (2002). *Getting started: Reculturing schools to become professional learning communities*. Bloomington, IN: National Educational Service.

Ertmer, P., & Simons, K. (2005). Scaffolding teachers' efforts to implement problem-based learning (PDF). *International Journal of Learning, 12*(4), 319-328.

Felder, R., & Brent, R. (1996). Navigating the bumpy road to student-centered instruction. *College Teaching, 44*(2), 43-47. Retrieved from http://www4.ncsu.edu/unity/lockers/users/f/felder/public/Papers/Resist.html

Groff, J. (2012). The nature of learning: Using research to inspire practice. In H. Dumont, D. Istance, & F. Benavides (Eds.), *Practitioner Guide* (p.1-11). OECD Publications.

Haberman, M. (1991). The pedagogy of poverty versus good teaching. *Phi Delta Kappan, 73*(4), 290-294.

Hackman, R., & Wageman, R. (2005). A theory on team coaching, academy of management. *The Academy of Management Review*, *30*(2), 269–87.

Harada, V., Kirio, C., & Yamamoto, S. (2008). *Collaborating for project-based learning in grades 9-12*. Columbus, OH: Linworth Publishing, Inc.

Harris, E., & Murray, L. (2011, Fall). *Effective team building for enhanced learning in the marketing curriculum*. Paper presented at the Marketing Management Association Fall Educators' Conference, St. Louis, Missouri. Retrieved from http://www.mmaglobal.org/publications/Proceedings/2011-MMA-Fall-Educators-Conference-Proceedings.pdf#page=167

Herreid, C. (2000). *Team learning: Cooperative learning in the science classroom*. National Center for Case Study Teaching in Science, New York, NY: University of Buffalo.

High Tech High (2015). *Project tuning*. Retrieved from www.hightechhigh.org/projects/projectFiles/.../PROJECT_TUNING.pdf

Hmelo-Silver, C., & Barrows, H. (2006). Goals and strategies of a problem-based learning facilitator. *Interdisciplinary Journal of Problem-Based Learning, 1*(1), 21-39.

Holbrook, J., Fasse, B., Gray, J. & Kolodner, J. (2001). Creating a classroom culture and promoting transfer with "launcher" units. *Georgia Institute of Technology.* Retrieved from http://www.cc.gatech.edu/projects/lbd/pdfs/aeralauncherunit.pdf

Holbrook, J. & Kolodner, J. (2000). Scaffolding the development of an inquiry-based (science) classroom. In Proceedings of the *International Conference of the Learning Sciences 2000 (ICLS)*, pp.221-227. Retrieved from http://www.cc.gatech.edu/projects/lbd/htmlpubs/scaffolddevelop.html

Hung, W. (2011). Theory to reality: a few issues in implementing problem-based learning. *Education Tech Research Dev., 59*(4), 529–552. doi: 10.1007/s11423-011-9198-1.

Inclusion BC (2015). *What is inclusive education?* Retrieved from http://www.inclusionbc.org/our-priority-areas/inclusive-education/what-inclusive-education

Johnson, D. W., & Johnson, R. T. (1994). *Learning together and alone: Cooperative, competitive and individualistic learning*. Boston: Allyn and Bacon.

Joyce, B., & Weil, M. (1996). *Models of teaching (5th ed.)*. Boston: Allyn and Bacon.

Kelson, A., & Distelhorst, L. (2000). Groups in problem-based learning (PBL): Essential elements in theory and practice. In D. Evenson & C. Hmelo-Silver (Eds.), *Problem-Based Learning: A Research Perspective on Learning Interactions* (pp.167-184), Mahwah, NJ: Lawrence Erlbaum Associates.

Kolodner, J., Camp, P., Crismond, D., Fasse, J., Holbrook, J., Puntambekar, S., & Ryan, M. (2003). Problem-based learning meets case-based reasoning in the middle school science classroom: Putting learning by design into practice. *Journal of the Learning Sciences*, *12*(4), 495-547.

Krajcik, J., Blumenfeld, P., Marx, R., & Soloway, E. (1994). A collaborative model for helping middle school science teachers learn project-based instruction. *The Elementary School Journal, 94*(2), 483-497.

Kyprianidou, M., Demetriadis, S., Tsiatsos, T., & Pombortsis, A. (2011). Group formation based on learning styles: Can it improve students' teamwork? *Education Tech Research Development, 60*(1), 83-110.

Labuhn, A., Zimmerman, B., & Hasselhorn, M. (2010). Enhancing students' self-regulation and mathematic performance: The influence of feedback and self-evaluation standards. *Metacognition and Learning, 5*(2), 173-194.

Lam, S., Cheng, R., Choy, H. (2009). School support and teacher motivation to implement project-based learning. *Learning and Instruction, 20*(6), 487-497.

Land, S., & Greene, B. (2000). Project-based learning with the worldwide web: A qualitative study of resource integration. *Educational Technology Research and Development, 48*(1). Retrieved from http://eric.ed.gov/?id=ED436175

Larmer, J., & Mergendoller, J. R. (2010). 7 essentials for project-based learning. *Educational Leadership, 68*(1), 1-4.

Maxwell, J. (2000). *Failing forward: Turning mistakes into stepping-stones*. Nashville, TN: Thomas Nelson, Inc.

Méndez-Morse, 2000. Launching professional learning communities: Beginning actions. *Southwest Educational Development Laboratory, 8*(1), 1-16. Retrieved from http://www.sedl.org/pubs/catalog/items/cha39.html

Mergendoller, J., & Thomas, J. (2005, June 14). *Managing project-based learning: Principles from the field.* Retrieved from http://bie.org/images/uploads/general/f6d0b4a5d9e37c0e0317acb7942d27b0.pdf

Miller, A. (2011, August 24). *How to write effective driving questions for project-based learning.* Retrieved from http://www.edutopia.org/blog/pbl-how-to-refine-driving-questions-andrew-miller

Mitchell, K., Shkolnik, J., Song, M., Uekawa, K., Murphy, R., Garet, M., & Means, B. (2005). *Rigor, relevance, and results: The quality of teacher assignments and student work in new and conventional high schools*. Prepared for the evaluation of the Bill & Melinda Gates Foundation's High School Grants, Washington, DC: The American Institutes for Research. Retrieved from http://smallhs.sri.com/documents/Rigor_Rpt_10_21_2005.pdf

Murray, I., & Savin-Baden, M. (2000). Staff development in problem-based learning. *Teaching in Higher Education, 5*(1), 107-120Neufeld, G. D. (2008). *Reaching troubled kids.* Paper presented at the BC Alternate Education Association Conference 2008, Vancouver, BC. Retrieved from http://www.sd68.bc.ca/edocuments/sss/resources_/neufeldrtknanai/NeufeldRTK_Nanaimo_feb24.pdf

Parent, A. (2011). Keep us coming back for more: Urban aboriginal youth speak about holistic education. *Canadian Journal of Native Education, 34*(1), 28.

Patton, A. (2012). Work that matters: The teacher's guide to project-based learning. *Paul Hamlyn Foundation.* Retrieved from http://www.phf.org.uk/page.asp?id=1987

Plotnik, R., & Kouyoumdjian, H. (2014). *Introduction to psychology* (10th ed.). Wadsworth, CA: Cengage Learning.

Raudsepp, E. (1992, Fall). Managing your career. *College Edition of the National Employment Weekly, 7–11.*

Ravitz, J., Hixson, N., English, M., & Mergendoller, J. (2012). *Using project based learning to teach 21st century skills: Findings from a statewide initiative.* Paper presented at the annual meeting of the American Educational Research Association, Vancouver, BC. Retrieved from http://bie.org/images/uploads/general/21c5f7ef7e7ee3b98172602b29d8cb6a.pdf

Ravitz, J. (2010). Beyond changing culture in small high schools: Reform models and changing instruction with project-based learning. *Peabody Journal of Education, 85*(3), 290-312. doi: 10.1080/0161956X.2010.491432.

Ritz, S. (2012, February). *A teacher growing green in the south Bronx* [Video file]. Retrieved from www.ted.com/talks/stephen_ritz_a_teacher_growing_green_in_the_south_bronx.html

Robertson, J., & Webber, C. (2002). Boundary-breaking leadership: A must for tomorrow's learning communities. In K. Leithwood & P. Hallinger (Eds.), *The Second International Handbook of Educational Leadership and Administration* (pp. 519-556). Netherlands: Kluwer.

Robinson, K. (2010, October). *Changing education paradigms* [Video file]. Retrieved from http://www.ted.com/talks/ken_robinson_changing_education_paradigms.html

Rodgers, C. (2002). Defining reflection: Another look at John Dewey and reflective thinking. *Teachers College Record, 104*(4), 842-866.

Rogers, M., Cross, D., Gresalfi, M., Trauth-Nare, A., & Buck, G. (2011). First year implementation of a project-based learning approach: The need for addressing teacher's orientations in the era of reform. *International Journal of Science and Mathematics Education*, *9*(4), 893-917. doi: 10.1007/s10763-010-9248-x.

Ruiz-Gallardo, J., Castaño, S., Gómez-Alday, J., & Valdés, A. (2011). Assessing student workload in problem based learning: Relationships among teaching method, student workload and achievement. *Teaching and Teacher Education 27*(3), 619-627.

Savery, J. (2006). Overview of problem-based learning: Definitions and distinctions. *Interdisciplinary Journal of Problem-based Learning*, *1*(3), 8-20.

Shankar, S. (2010). Self-regulation: Calm, alert, and learning. *Canadian Education Association*, *50*(3). Retrieved from http://www.cea-ace.ca/education-canada/article/self-regulation-calm-alert-and-learning

Sherman, R., & Webb, R. (2001). *Qualitative research in education: Focus and methods.* Milton Park, Oxon: RoutledgeFalmer.

Thomas, J. (2000). *A review of research on project-based learning.* Retrieved from http://www.bobpearlman.org/BestPractices/PBL_Research.pdf

Tomlinson, C. (2001). *How to differentiate instruction in mixed-ability classrooms (2nd ed.).* Alexandria, VA: ASCD.

Tretten, R. & Zachariou, P. (1997). *Learning about project-based learning: Assessment of project-based learning in Tinkertech schools.* San Rafael, CA: The Autodesk Foundation.

University of Northern British Columbia (2006). *Policies and procedures: Research involving human participants.* Approved by Senate, September 20, 2006.

Ward, J., & Lee, C. (2002). A review of problem-based learning. *Journal of Family and Consumer Sciences Education, 20*(1), 16-26.

World Wide Fund for Nature, (2005). *Cross-cutting tool: Stakeholder analysis.* Retrieved from www.panda.org/standards/1_1_stakeholder_analysis

Vardi, I., & Ciccarelli, M., (2008). Overcoming problems in problem-based learning: A trial of strategies in an undergraduate unit. *Innovations in Education and Teaching International, 45*(4), 345-354.

Zumbrunn , S., Tadlock, J., & Roberts, E. (2011). *Encouraging self-regulated learning in the classroom: A review of the literature.* Metropolitan Educational Research Consortium, Virginia Commonwealth University. Retrieved from http://www.self-regulation.ca/download/pdf_documents/Self%20Regulated%20Learning.pdf

Appendix A: Supplementary Resources

Alberta Ministry of Education (2010). Chapter 3: Developing learner profiles. In *Making a Difference: Meeting diverse learning needs with differentiated instruction* (pp. 23-24). Retrieved from http://education.alberta.ca/media/1233960/6_ch3%20learner.pdf

- The use of learner profiles for guiding project design

Berger, R. (2003). *An ethic of excellence: Building a culture of craftsmanship with students.* Portsmouth, NH: Heinemann.

- How to build a culture of peer assessment in the PBL classroom

British Columbia Ministry of Education (2013). *The B.C. education plan.* Retrieved from http://www.bcedplan.ca/

- Current education goals to develop student 21st century skills, the impetus for implementing PBL

British Columbia Ministry of Technology, Innovation and Citizen's Services (2014). *Guide to the Freedom of Information and Protection of Privacy Act.* Retrieved from http://www.cio.gov.bc.ca/cio/priv_leg/foippa/foippa_guide.page

- Safety guidelines for use of online sites/tools such as Google Suite

Boss, S., & Krauss, J. (2007). *Reinventing project based learning: Your field guide to real-world projects in the digital age.* Washington, DC: International Society for Technology in Education.

- A comprehensive resource for the effective integration of technology in PBL

Boss, S., (2013). *PBL for 21st century success: Teaching critical thinking, collaboration, communication and creativity*. Retrieved from http://bie.org/shop/product_detail/pbl_for_21st_century_success

- Steps to facilitate and assess the four C's – Critical Thinking, Collaboration, Creativity and Communication - through well-designed projects

Brownlie, F., & Schnellert, L. (2009). *All about thinking*. Winnipeg, MB: Portage & Main Press.

- Ideas for building inclusive academic units that engage critical and reflective thinking

Buck Institute of Learning (2014). *PBL project checklist*. Retrieved from http://bie.org/

- A source of excellent PBL blogs and resources such as: PBL essential elements checklists, project design and assessment templates, sample project rubrics, driving question templates and student project planning forms

Centre for Applied Special Technology (2014). *What is universal design for learning?* Retrieved from http://www.cast.org/udl/index.html

- Describes UDL as a means to an inclusive, differentiated classroom for all learning styles

Costello, B., Wachtel, J., & Wachtel, T. (2010). *Restorative circles in schools: Building community and enhancing learning*. Bethlehem, PA: International Institute for Restorative Practices.

- Practical steps and anecdotes towards a positive classroom culture through relationship building and problem solving with talking circles

Holbrook, J., Fasse, B., Gray, J. & Kolodner, J. (2001). Creating a classroom culture and promoting transfer with "launcher" units. *Georgia Institute of Technology.* Retrieved from http://www.cc.gatech.edu/projects/lbd/pdfs/aeralauncherunit.pdf

- PBL "launcher units" to pre-teach 21st century skills needed for projects

Holbrook, J., & Kolodner, J. (2000). Scaffolding the development of an inquiry-based (science) classroom. *Georgia Institute of Technology.* Retrieved from http://www.cc.gatech.edu/projects/lbd/htmlpubs/scaffolddevelop.html

- Approaches to develop a collaborative PBL science classroom.

Larmer, J., & Mergendoller, J. R. (2010). 7 essentials for project-based learning. *Educational Leadership*, *68*(1), 1-4.

- A summary of the essential elements of PBL needed in every project design

Mergendoller, J., & Thomas, J. (2005). Managing project-based learning: Principles from the field. Retrieved from http://bie.org/images/uploads/general/f6d0b4a5d9e37c0e0317acb7942d27b0.pdf

- Useful strategies for time and project management in the PBL classroom

Patton, A., (2012). Work that matters. *The Paul Hamlyn Foundation.* Retrieved from http://www.innovationunit.org/sites/default/files/Teacher's%20Guide%20to%20Project-based%20Learning.pdf)

- An excellent start up guide to understanding and implementing PBL

Tomlinson, C. (2001). *How to differentiate instruction in mixed-ability classrooms (2nd ed.).* Alexandria, VA: ASCD.

- Tools, templates and ideas to achieve differentiated learning in the classroom

Appendix B: Project Tuning Protocol

1. **Overview** – 10 min

   Presenter gives an overview of the work and explains goals and context of the project. Participants then have an opportunity to look at "the work" (e.g. project handouts, rubrics, student work, etc.). **The presenter then shares a dilemma by *framing a question* for the group to address during the discussion.**

2. **Questions** – 10 min

   Ask **clarifying and probing** questions of the presenter. **Clarifying** questions have brief, factual answers and are intended to help the person asking the question develop a deeper understanding of the dilemma (e.g. "How were the groups chosen for this activity?"). **Probing** questions help the presenter expand his or her thinking about the dilemma (e.g. "How did each student demonstrate…?", or "What evidence did you gather…?"). Questions should not be "advice in disguise", such as "Have you considered…?"

3. **Discussion** – 10 min

   The presenter reframes the question if necessary and is then physically removed from the group. The group discusses the dilemma and attempts to provide **insight on the question** raised by the presenter. It may help to begin with **positive feedback**, such as "What went well with the project?" and then move on to **constructive feedback**, such as "They might want to try...". Resist the urge to speak directly to the presenter.

4. **Debrief** – 10 min

   a. The presenter has the opportunity to **respond** to the discussion. It is not necessary to respond point by point to what others said. The presenter may share what struck him or her and what next steps might be taken as a result of the ideas generated by the discussion. **Participants are silent**.

   b. The **facilitator leads a conversation about the group's observation of the process**. Questions posed to the group might include: Did we have a good question? Did we stick to the question? When was a moment when the conversation made a turn for the better? Was there any point where we went off track? Did our probing questions really push the thinking of the presenter?

   c. **Further suggestions or ideas.** Informal discussion and feedback.

Adapted from High Tech High (2015)

Appendix C: World Biomes Project Rubric

PBL Project Rubric				
Individual Performance	**Below Standard**	**Approaching Standard**	**At Standard**	**Above**
Takes responsibility and helps team	Rarely: Prepared to work Appropriate use of tech. tools Quality of feedback given Receiving feedback Team problem solving Questioning, engaging and expressing ideas in discussion	Sometimes: Prepared Uses tech tools appropriately Provides helpful feedback Applies feedback Works with reminders Cooperates with team Expresses ideas clearly, asks probing questions, and elaborates in discussions	Consistently: Prepared and well informed on the project topic Uses technology tools as agreed Does tasks Uses and provides helpful feedback Solve problems with team Makes discussions effective by clearly expressing ideas, asking probing questions, making sure everyone is heard	
Analyze driving question and begin inquiry	Sees only superficial aspects of, or one point of view on, the Driving Question (DQ) Questions require more initial research or content knowledge	Identifies some central aspects of the DQ, but may miss complexities or not consider various points of view Asks some follow-up questions about the topic but does not dig deep	Understands central aspects of the DQ by identifying in detail what needs to be known and considering various points of view on it Asks follow-up questions that focus or broaden inquiry	

PBL Project Rubric				
Individual Performance	**Below Standard**	**Approaching Standard**	**At Standard**	**Above**
Gather and Evaluate Information	Unable to integrate information to address the Driving Question; gathers too little, too much, or irrelevant information, or too few sources Accepts information at face value	Attempts to integrate information to address the Driving Question, but it may be too little, too much, or gathered from too few sources; some of it may not be relevant Understands that the quality of information should be considered	Integrates relevant and sufficient information to address the Driving Question, gathered from multiple and varied sources Thoroughly assesses the quality of information	
Generate and Select Ideas	Stays within existing frameworks; does not use idea-generating techniques Selects one idea without evaluating the quality of ideas Does not ask new questions or Elaborate on the selected idea Reproduces existing ideas Does not consider or use feedback and critique to revise product	Some original ideas for product(s), but could develop with of idea-generating techniques Evaluates ideas, but not thoroughly before selecting one Asks a few new questions but may make only minor changes to the selected idea Shows some imagination when shaping ideas but still conventional Considers some feedback to revise but does not seek it out	Uses idea-generating techniques to develop several original ideas for product(s) Carefully evaluates the quality of ideas and selects the best one to shape into a product Asks new questions, takes different perspectives to elaborate and improve on the selected idea Uses imagination, going outside conventional boundaries	

PBL Project Rubric				
Individual Performance	**Below Standard**	**Approaching Standard**	**At Standard**	**Above**
Explanation of Ideas & Information	Does not present arguments, ideas, or findings clearly, concisely, and logically; argument lacks supporting evidence Selects information, develops ideas and uses a style inappropriate to the purpose, task, and audience Does not address alternative or opposing perspectives	Presents information, findings, arguments and supporting evidence in a way that is not always clear, concise, and logical Attempts to select information, develop ideas and use a style appropriate to the purpose, task, and audience but does not fully succeed Attempts to address alternative or opposing perspectives, but not clearly or completely	Presents information, findings, arguments and supporting evidence clearly, concisely, and logically; audience can easily follow the line of reasoning Selects information, develops ideas and uses a style appropriate to the purpose, task, and audience Clearly and completely addresses alternative or opposing perspectives	
Presentation of learning	Separate rubric			